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CONFERENCE ON THE PRESENT AND FUTURE DEVELOPMENT OF HYDROMETEOROLOGICAL FORECASTING METHODS IN THE USSR

The above-named conference of forecasters, scientists, and practical workers, convened by the Main Administration of the Hydrometeorological Service, was held from 26 March to 3 April 1948. The reports heard and discussed at the conference were divided into four groups: (1) long-range weather forecasts; (2) short-range weather forecasts; (3) hydrological forecasts and ice forecasts; and (4) organizational problems of the Forecasting Service.

The most important report in the first group was "Present Long-Range Forecasting Methods" by S. T. Pagava, Doctor of Physicomathematical Sciences, Central Forecasting Institute. Pagava stressed the following points:

1. The reliability of long-range weather forecasts depends upon knowing the laws governing the development of atmospheric macroprocesses and understanding the role of the underlying surface and heat balance in the atmosphere.

2. Many researchers are trying to clarify the relation between circulation anomalies and weather conditions or directly between weather conditions in different regions at different times. Some scientific workers base their works upon the cyclic nature of the individual meteorological elements; others rely upon the assumption that atmospheric processes are wave-like. Most meteorologists, starting from the assumption that the characteristics of atmospheric circulation must be known to solve the problem of long-range weather forecasts, are studying the actual circulation types.

3. At present, there are Long-Range Forecast Services in the US and in the USSR; there was one in Germany. In the US, 5-day and 30-day operational forecasts are produced. These forecasts are drawn up on the basis of the circulation index, breakdown of synoptic processes, and extrapolation of current synoptic processes. There is still no generally accepted method for long-range weather forecasts in the US.

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4. A Long-Range Weather Service was organized much earlier in the USSR (dating from 1922, when long-range forecasts were produced by the Mul'tanovskiy method) than in other countries and the method of long-range forecasting has undergone more refinements in the Soviet Union than in other countries. However, the state of the method is such that present long-range weather forecasts do not satisfy the consumers. Large-scale work must be done on the study of the formation, development, destruction, and replacement of macrosynoptic processes. Special attention should be given to the high-altitude thermobaric field and to the influence of the underlying surface upon the formation of macroprocesses, e.g., the influence of oceans and iciness of seas.

5. The following methods must be improved to increase the quality of long-range forecasts in the next few years: (1) forecasting the amount of precipitation; (2) forecasting the weather for two synoptic seasons; (3) establishment of quantitative criteria to determine the boundaries of natural synoptic seasons and periods; and (4) the succession of natural synoptic seasons.

6. The following data are necessary for successful research work in long-range forecasting: climatological, synoptic, and aerological data on sea and ocean conditions from the whole world for both the current season and former years. Expansion of the network of aerological stations and, more important, improvement of aerological observations are also needed.

A new presentation of the prognostic potentialities inherent in the monsoon theory of climate and weather was given in Academician V. V. Shuleykin's report, in which he proposed that:

1. The flow of radiant energy from the sun and the reverse flow into interplanetary space creates movements in the atmosphere similar to the work of heat machines. Each of these "machines" work, in accordance with thermodynamic principles, between a heat source and a sink. There are two types of machines in the atmosphere, namely: machines of the first type, having as a heat source the tropical belt of the earth and as a sink the high-latitude regions; and machines of the second type, whose heat sources and sinks (oceans and continents) are interchangeable, depending upon the season.

2. Climate is the averaged conditions of "heat machines." Fluctuations of the condition of "heat machines" are weather changes.

3. In winter, the flow of cold air from the continents in monsoon currents and the flow of warm air from oceans and inner seas to the continents in antimonsoon currents cause heat transfer from oceans to continents. Turbulent exchange takes place constantly between the lower (monsoon) and upper (antimonsoon) layers.

4. Temperature isanomalies serve as the temperature characteristic of a monsoon field.

5. Analysis of thermal currents along a meridian shows that the amount of transferrable heat can be calculated quite accurately using the Fourier formula, with the coefficient of turbulent heat conductivity substituted for the coefficient of molecular heat conductivity.

6. Analysis permits one to calculate the amounts of heat which are expended along the path of the monsoon flow in heating the atmosphere and which thus participate in the heat balance of the atmosphere in a certain region of the continent.

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7. The theory permits us to determine the approximate relationship between temperature and pressure characteristics of a monsoon field, expressed by the basic equation of a monsoon field, i.e., grad p = -P grad T, where T is the temperature anomaly, p is pressure and P, having the dimensions pressure/temperature, is a universal quantity which is extremely useful for solving many different problems.

8. The temperature distribution at the earth's surface is closely related to dynamic processes occurring throughout the troposphere because a decisive role is played by the active layer, through which the monsoon currents pass. These are the physical bases of climate.

9. The existence of two currents in mutually opposite directions, monsoon and antimonsoon, produces self-excited oscillation processes in the monsoon field which are manifested as weather changes.

10. The concept of thermobaric waves in the atmosphere owes its origin to feedback between pressure oscillations and air temperature oscillations.

11. Weather changes occur in the form of standing thermobaric waves, i.e., in the form of thermobaric seiches.

12. Standing waves are caused by nonhomogeneities of the underlying surface. An abrupt change of wave velocity always causes wave reflection to a greater or lesser degree. Reflected waves join with incident waves to produce a system of standing waves. The intuitive constructions of B. P. Mul'tanovskiy now have a firm physicomathematical foundation: the so-called "natural synoptic region" of Mul'tanovskiy is a region enclosed within a closed junction line; the so-called "rhythms" and "natural synoptic periods" are natural oscillation periods of the system caused by a certain configuration of the junction lines and the physical constants of air.

13. The most pronounced oscillation phenomena occur in changes of the regime to directly opposite conditions. Consequently, in the self-excited oscillation system "ocean-atmosphere (continent)," the most pronounced oscillations must occur during changes of monsoon seasons; the marked oscillations in spring, known as the "May cold spell," often cause great damage to agriculture; the similar phenomenon in fall is Indian summer.

14. Short-range weather forecasts must be drawn up on the basis of various refinements of I. A. Kibel''s equations. The problem of short-range forecasts will be solved decisively, given sufficient reliability of meteorological and aerological observations and of calculating techniques.

15. All long-range forecasts, for both short and long periods in advance, are different in principle. The use of Kibel''s equations cannot solve this problem.

An interesting if contestable report, "The Periodicity of Solar Processes and Their Influence Upon Atmospheric Phenomena," was made by P. P. Predtechenskiy, Main Geophysical Observatory.

Ye. N. Blinova, Doctor of Physicomathematical Sciences, told of a highly promising and thorough investigation in her report, "Potentialities of Long-Range Weather Forecasting With the Help of Hydrothermodynamics." In his paper "Chain Processes and the Problem of Weather Forecasts," M. A. Sarymsakov, president of the Uzbek Academy of Sciences, discussed statistical methods employed in long-range weather forecasts which might be very useful, given proper treatment as auxiliary methods to make the physicometeorological analysis of atmospheric processes more accurate.

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No serious, far-reaching criticism was advanced in the statements of the opponents or in discussions on these papers, although some of the major premises of the reports caused serious protests (the Mul'tanovskiy and Pagava "rhythms," for example).

In the second group of reports, on short-range forecasts, a great deal of attention was given to the Kibel' method and to advective-dynamic analysis.

The report of Kh. P. Pogosyan, Doctor of Geographical Sciences, dealt with the present status of the method for short-range weather forecasts and ways of improving it. Pogosyan pointed out that the most difficult problem is to forecast the evolution of processes; incorrect prognosis of evolution usually causes an incorrect forecast. This obstacle has been successfully surmounted by the advective-dynamic analytical method devised by Kh. P. Pogosyan and N. L. Taborovskiy. At first empirical, the studies have now obtained confirmation in Kibel''s theory. Problems of thermodynamics will come to the forefront in the new era. At the same time, studies must be continued on the theory of evolution of the pressure field. Another responsible task is the study of thermodynamic processes in fronts (evolution of cloudiness and precipitation) in connection with frontogenesis and evolution of the thermobaric field of the troposphere. Theoretical and empirical researches in this field should be conducted simultaneously and in harmony. Tasks of regional synoptics should be worked out by meteorologists in the field in two directions: (1) study of microsynoptic processes in various geographical regions of the USSR and foreign nations, and (2) studies of local effects and processes.

I. A. Kibel', Corresponding Member, Academy of Sciences USSR, reported on the hydrodynamic method of short-range weather forecasting which he devised.

Those submitting reports, their opponents, and most persons participating in the discussions emphasized the great accomplishments of Soviet meteorologists in developing short-range forecasting methods, noted the unquestioned priority of Soviet science in this field, and discussed the great potentialities of these methods. It was unanimously agreed that serious attention should be given to the training and refresher training of highly-qualified synoptic personnel who could work with new methods and develop them, and also to basic improvement of the method of disseminating special literature published by the Hydrometeorological Publishing House, as this method does not work well for the outlying regions. Serious demands must also be made upon the network of hydrometeorological stations producing aerological observations.

Next, the following reports were heard and discussed: M. A. Velikanov's "Theoretical Principles Governing the Forecasting of Rain Floods," G. R. Bregman's "The Present Status of River Ice Forecasts," G. P. Kalinin's "Formation of a Spring Flood and Forecast of Its Hydrograph," A. V. Ogiyevskiy's "The Possibility of Predetermining Rain and Snow Floods," N. A. Belinskiy's "Marine Hydrometeorological Forecasts," D. V. Karelin's "Ice Forecasts for Arctic Seas," and N. V. Somov's "Hydrological Forecasts for Power Engineering Purposes."

In his report on organizational problems of the Forecasting Service, Candidate of Geographical Sciences S. M. Prostyakov, Chief of the Administration of the Forecasting Service, Main Administration of the Hydrometeorological Service, made the following points:

1. There is no doubt about the efficiency of retaining the synchronous time of observations introduced in the USSR in 1947.

2. Aerological observations, which are very important for weather forecasts at this time, have a number of major defects in organization and methodology.

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3. The network of points producing vertical temperature soundings must be expanded considerably within the next 2 or 3 years. The entire network of sounding points must produce observations regularly, not less than 2 times per day. A reliable, cheap radiosonde is needed to provide suitable quality of observations and heights of ascent.

4. It is inefficient to produce vertical soundings by airplanes. Horizontal airplane soundings should be developed extensively.

5. The important problem of wind observations at high altitudes under sea conditions should be solved.

6. The organization of meteorological observations has deficiencies which are reflected mainly in unsatisfactory coverage of unpopulated regions by stations, in insufficient number of ship observations, and in poor observations on the height of the lower cloud boundary, horizontal visibility, and gustiness.

7. The problem of the density of the meteorological network can be solved partially by the installation of automatic radio weather stations (ARMS).

8. Observations on the height of the lower cloud boundary must be improved by introducing instrument observations (beam searchlights, pibal observations without theodolites) into the network.

9. DM-6 or Sharonov diaphanoscopes should be distributed to the network now to improve observations on horizontal visibility. The illustrative range of visibility which can be determined by these instruments is an objective characteristic of atmospheric transparency. It is important that the problem of observations on night visibility and observations at sea be solved.

10. Observations on gustiness with the help of anemoscopes are inadequate. A new reliable instrument which would indicate the maximum wind velocity in gusts is necessary.

11. To obtain more complete information in organizations of the Weather Service, additional reports on simultaneously observed meteorological elements with their extremal values indicated should be introduced into the practice of a selected network of meteorological stations.

12. Scientific-methodological works are required to obtain better methods of reducing pressure to sea level.

13. Actinometric observations, necessary for calculations of the radiation balance, supplementary optical observations (on the blue sky and red glow of sunset, for example) which may help to clarify upper air properties, and observations on atmospherics are all important for research in new forecasting methods.

A similar report, "The Demands of Hydrological Forecasting Upon Hydrological and Meteorological Observations," was submitted by Ye. G. Popov, Candidate of Technical Sciences. These demands can be reduced to four: (1) radical improvement of current reports; (2) improvement of the main types of observations; (3) extensive organization of experimental works in laboratories and under natural conditions; and (4) improvement and speed-up of the processing and publication of observational data.

In conclusion, Academician V. V. Shuleykin, Chief of the Main Administration of the Hydrometeorological Service, gave a long speech in which he urged that the advocates of different schools and methods conduct further work in cooperation. The conference adopted a number of resolutions and set up an editorial commission to prepare the works of the conference for publication.

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